MATHEMATICS PROBLEMS

5 points

1) The pull of gravity on the surface of the moon is about 1/6 that of Earth, and on the surface of Mars it is about 1/3 that of Earth. If someone weighs 25 pounds on the moon, what will they weigh on Mars?

2) Suppose a rover is designed to travel not more than 1000 meters from the vehicle which carried it to the surface of Mars. How much area would it be able to explore?

10 points

3) The first human to travel through space in a complete orbit around the Earth rode at an altitude of about 330 kilometers above the surface of the planet. Considering that the radius of the Earth is about 6600 kilometers, what distance did this astronaut travel during the orbit? If the complete orbit took 108 minutes, what was his speed?

4) Light travels through empty space at a speed of about 300,000 (3×10^5) kilometers per second. The distance light would travel through space in a year is called a "light-year," and the distance that light would travel through space in one minute is called a "light-minute." What is one light-minute, in kilometers? Do some research and calculation to determine the maximum distance between the Earth and Mars in "light-minutes." Explain what this means to people trying to communicate between these planets (radio signals travel at the same speed as light).

5) Astronauts can require around 900 grams of water per day to survive in space. Suppose a planned mission to Mars involved 300 days of travel to the planet, 530 days on Mars, and 200 days of travel to return to Earth. If it costs $6.60 per gram to lift equipment and supplies out of the Earth's gravitational field, what would it cost to lift all of the water an astronaut might need on such a mission? (Note: In an actual mission, most of this weight could be saved through recycling).

15 points

6) Draw a diagram showing the path, mission timetable and critical events of the first human mission to the Moon. Explain why the path is not a straight line. Given that the moon is about 400,000 kilometers from the Earth, and travels around the Earth about once every 28 days, how far did the moon travel in its orbit from the time that the Apollo 1 astronauts launched to the point where they landed on the moon?

7) Astronauts in microgravity lose calcium from their bones. Based on some experiments this can be estimated as a rate of .28 grams of calcium loss per day. Suppose an astronaut on a mission to Mars spent 50 days of travel time (in microgravity) to get there. If the astronaut recovered calcium while on Mars at a rate of .1 grams per day, how long would he or she have to stay on the surface to recover all bone calcium that had been lost while in space?

25 points

8) The Earth travels around the Sun once every 365 days. Mars makes a complete orbit every 687 days. How many days are there between times when one planet "passes" the other?

9) Traveling between planets requires the ability to predict their motion exactly. Some of the rules of this motion were discovered hundreds of years ago by a man name Johannes Kepler. Explain, with diagrams, Kepler's Law of Planetary motion, and how he discovered it.

MISSION TO MARS

The diagram below shows the orbits of Earth and Mars around the Sun, and the relative positions of the two planets on February 1, 2014.

The Earth travels around the Sun about once every 365 days. Mars travels around the Sun about once every 687 days.

The orbits are slightly elliptical, but for the purpose of this activity they are assumed to be circular.

1) If a manned mission to Mars leaves Earth on February 1, 2014, and takes 150 days to arrive to Mars, find the new position of Earth on the date of the Mars landing. Mark this on the diagram with the number "2." (Hint: Note that 365 days is equivalent to 360° of the circular path of the Earth.)

2) Find the new position of Mars at the time of landing. Again, mark it with the number "2." (In this case, 687 days is equivalent to 360°.)

3) Use the scale of the drawing to estimate the distance between Earth and Mars at the time of landing. How long would it take a radio signal, traveling at 3×10^5 kilometers per second, to travel between the planets?

4) If the astronauts remain on Mars for 619 Earth days, what will the new positions of the planets be at the end of their stay? Mark these on the diagram with the number "3."

5) If it takes 110 days for the astronauts to return to Earth, find and mark the position of the Earth on the date of Earth landing with the number "4."

6) Optional: Design an alternate schedule for a manned Mars mission leaving on the same date, in which the travel times are shorter and the time spent on Mars is longer. Keep in mind that you do not want Mars on the opposite side of the Sun at the crucial times of Mars landing and Mars takeoff, since it would be impossible to communicate between the two planets at that time.